LAB University of Applied Sciences

# Impact of the Russia-Ukraine war on Finlands' energy policy

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**Abstract**


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Abstract

In February 2022 Russia launched its illegal and unjustified invasion of Ukraine. EU has imposed massive sanctions against Russia and in response, Russia has restricted its energy supplies to Europe. The situation has led to an unprecedented energy crisis in Finland and Europe.

This thesis gathered information from literature sources on Finland's energy policy and the role of Russian energy in it. Russia's energy supplies have traditionally covered over a third of Finland's energy imports. Now because of Russia's actions in Ukraine Finland aims to phase out Russian energy as soon as possible.

The purpose was to explore the ways in which the Russia-Ukraine war may impact Finland's energy policy. The conclusions were that it seems likely that the war will speed up the green transition in Finland. Finland is coming out of the energy crisis faster than the rest of Europe and is simultaneously experiencing great momentum in green energy investments.



Keywords

Energy, green transition, the EU, Russia, sanctions

Contents

# 1 Introduction

## 1.1 Background

On the 24th of February 2022, Russia launched an invasion of Ukraine leading to a war that has lasted for over a year at the time of writing this thesis. The unprovoked nature of the attack, dismissal of several international agreements, and multiple war crimes committed by Russia have caused Europe and Western countries to set unprecedented sanctions against Russia. (European Council 2023a.) As a response, Russia, one of the largest fossil fuel producers in the world, has started to use its energy export as a political weapon. (Warrington 2022.)

In normal conditions, energy delivery reliability and security of supply are not visible in society. Russia's military invasion of Ukraine in February 2022 has quickly brought attention to and raised discussion about the security of Finland's energy supply and the energy imports from Russia. (Huttunen, Kuuva, Kinnunen, Lemström, Hirvonen 2022, 10.) It has become Finland's objective to phase out Russian fossil energy, and green transition may be the key in doing so. Moving towards more sustainable and weather-dependent energy production comes with its own set of unique challenges, however. (Huttunen et al. 2022, 21.)

What makes the future of energy policy, and energy markets, such fascinating topics are the changes we can see approaching. The energy market has gone through a significant journey since the industrial revolution, and now the battle with climate change will continue to reshape the energy industry. For decades fossil fuels have dominated the energy market, but now sustainability has quickly risen to be one of the biggest megatrends around. At the same time, we know that fossil fuels will eventually run out. Now, in the picture has come the war in Ukraine, which will bring new future views to the energy sector.

By initiating the war against Ukraine, Russia, one of the largest oil and fossil fuel producers in the world, has proven its unpredictability and gotten the world to turn its back on the country. The war has served as a wakeup call to how a high dependency on another country for a necessity like energy is tremendously dangerous, and secondly, that energy can be used as a tool in warfare. The war has united the European Union in its action to take measures against Russia and support Ukraine, which is something noteworthy when thinking about the future of the common energy policy of the EU. (European Council 2023b.) No matter what the outcome of the war is or how the sanctions will change over time, it is undeniable that most (if not all) countries in Europe will take the time to re-evaluate their energy policy and take matters to secure their energy supply.

The reason for choosing to write this thesis on the impacts of the Russia-Ukraine war on Finland's energy policy is the timeliness of the topic. At the time of writing this thesis, the war in Ukraine is still ongoing, and the future is very much unknown. The situation is something we have never experienced before. While researching the topic can be more challenging as new information continues to come out all the time, the timeliness of the topic and the lack of existing research on it bring value to this thesis. The purpose of this thesis is to explore ways the Russia-Ukraine war may impact Finland's energy policy.

## 1.2 Research question and limitations

This thesis identifies and predicts how Finland's energy policy is going to change in the future as a result of the war in Ukraine. It can be expected that changes to Finland's energy policy and energy strategy will be implemented over the next months and years, especially as the new government was recently elected and a new energy and climate strategy will be prepared by the new ministry.

What is more challenging to predict, however, are the wider long-term impacts that may follow the crisis. Russia's invasion of Ukraine has been a startling wake-up call to how energy, and the restriction of its export by producer countries, can be used as a tool in political warfare. It has also shown us how important it is to ensure the security of energy supply. Understanding the risks and opportunities the war in Ukraine can bring on Finland's energy policy, as well as considering potential future perspectives can help to prepare for the future and provide a foundation for making better decisions concerning it.

The main research question in this thesis is:

How will the Russia-Ukraine war impact Finland's energy policy?

To help seek an answer to that question, two sub-questions have been created for support. They are:

1. How will the sanctions set on Russia impact Finland's energy policy?

2. How will the Russia-Ukraine war affect the green transition in Finland?

To answer those questions, literature sources will be relied upon for information, and predictions will be formed based on the information collected with the support of existing knowledge of energy markets and trends.

The time-sensitive nature of the topic brings some limitations to this research. More information continues to come out all the time, as the situation around the war in Ukraine keeps unfolding. With that, there is a risk that new information will object to the knowledge that was available at the time of writing this research, or on the other hand, valuable information can surface too late to be included in this thesis. This thesis is written based on the information available at the time and could therefore not perfectly reflect everything that is known at the time of reading it.

Other limitations of this thesis include the lack of previous research and the scope of discussion. Relating to the previous point about the time sensitivity of the subject, there is a lack of previous research on the impacts and outcomes of the war in Ukraine. That is for the simple reason, that we do not know the outcome yet. While making predictions is always speculative, the lack of previous research and the war still being ongoing just further add to this factor. The second-mentioned limitation is the scope of discussions. The authors' lack of experience in conducting research and writing academic papers of this size can bring limitations to the scope and depth of discussions in this thesis.

## 1.3 Research method and data gathering

This research is a literature review. The information on this research will be collected and formed through various articles, research papers, and news articles. In the first parts of the thesis, the reader will be provided with information on different energy sources, Finland's energy policy, the significance of the EU on Finland's energy policy, green transition, Russian energy, and the Russia-Ukraine war.

In the second part of this thesis, we will get into the research questions and tie the two topics, the energy policy of Finland, and the ongoing war in Ukraine, together to find conclusions on how one might be affected by the other. The predictions and conclusions on how the Russia-Ukraine war may impact Finland's energy policy will be formed based on the theory from the first part of the thesis. The war in Ukraine and the energy policy of Finland are researched mainly separately but tied together in this thesis through the knowledge of the topics, knowledge of the energy markets, and the understanding of trends and megatrends. By the end, the reader will hopefully understand how the Russia-Ukraine war may impact Finland's energy policy and shape the future of our energy sector.

## 1.4 Theoretic framework

This thesis approaches the topic from the idea that the crisis in Ukraine can, and most likely will, weaken Russia's position in the European energy market long-term. Due to Russia's

actions Finland and the EU aim to phase out Russian energy as quickly as possible. In light of the green transition and the use of fossil fuels being the largest contributor to climate change, it is safe to assume that the lost energy supply would be aimed to be replaced with renewable energy, eventually.

The key topic in this research is energy policy. National energy policy is the scheme of the government regarding the production, management, distribution, availability, and consumption of energy in the country, as well as the different legislative and taxational methods that relate to the previously mentioned. Besides Finland's national energy policy, the EU's common energy policy is another important topic in this thesis, as it closely affects the energy policy of Finland and sets guidelines for it.

Europe is an important player in this case. As a political and economic union, the EU has significant importance in Finland in terms of political and economic decision-making. That said, major events in one of the European countries, whether members of the EU or not, can affect the other European countries. The war in Ukraine can be considered a prime example of this, although an extreme one. Europe is a remarkable factor in this research in terms of energy resources, infrastructure, and transit of energy within Europe, as well as through the possibility of the war expanding in Europe.

Sanctions are practically an economic way of fighting as opposed to physically fighting another country. They are typically financial penalties applied by one or more countries against another country, group, or individual, to settle a conflict or prevent its escalation. They can be used for other purposes such as curtailing nuclear proliferation or counterterrorism as well. (Masters 2019.) The sanctions set on Russia have an impact on Finland as they restrict trade between the two countries. This thesis focuses on the sanctions that relate to energy.

The green transition is another key topic in this thesis. What is meant by the green transition, is the aim and actions taken to make a country or an area, in this case, Finland, carbon neutral. Finland has committed to becoming carbon neutral by the year 2035, and many of the policy actions relate heavily to the energy sector. Some of the main goals in the green transition stated by the Ministry of Finland, are to make Finland a world leader in the hydrogen and circular economies, and in emission-free energy systems as well as to increase energy efficiency. The green transition is a key factor when investigating the future views of Finland's energy policy. (Ministry of Finance Finland 2023.)

The main sources of information used in this thesis are the website of the Ministry of Economic Affairs and Employment of Finland, and all the information and documents found

there, such as the energy strategy of Finland, information on energy investments, and information on the security of energy supply, etc. The website of the Ministry of the Environment and information found on it will be used as a source as well, as will the website of the European Commission and all the information related to energy and energy strategy that can be found there. Due to the time-sensitive nature of the topic, different news articles will also be used as a source, as they tend to provide the timeliest information throughout the research process.

# 2 Energy sources

According to the European Environment Agency, fossil fuels are the most used energy resource in Europe to this day. 77% of European's energy needs are being fulfilled with fossil fuels, 14% nuclear energy and the rest from renewable energy. (European Environment Agency 2023.) While the share of renewable energy is growing rapidly, it will take time for it to overtake fossil fuels globally. What makes the transfer to renewable energy challenging is the energy systems being built around fossil fuels, the unique qualities of fossil fuels, and them being economical and practically abundant for now (Gross 2020).

Some energy sources can be used directly as they are, but energy often gets transferred into electricity. The one important difference between fossil energy and renewable energy is their ability to be stored, the stability of their production, and their ability to supply reliable baseload power and peaking power. Baseload power refers to the minimum amount of energy that needs to be produced at each moment to answer to the energy needs of a nation. (Energy Education 2023a.) If the minimum energy demand is not met, our quality of life and economy will suffer. The energy demand also varies each day and fluctuates throughout the day, so besides baseload power plants, we also need dispatchable peaking power plants. (Energy Education 2023b.) Fossil fuels and nuclear power are great for supplying baseload power, due to their ability to produce a constant flow of energy. Renewable energy on the other hand is mostly weather dependent causing the production of it to fluctuate.

## 2.1 Fossil fuels

Fossil fuels are non-renewable fuels that have been formed from biomass and stored underground millions of years ago. They contain carbon and hydrogen, which can be burnt for energy. Despite the rapid growth of renewable energy, fossil fuels provided 85% of global energy needs in 2018. In the same year, 2018, the three largest fossil fuel producer countries in the world were the U.S., Russia, and Iran. (Rapier 2019.)

Certain qualities of fossil fuels are difficult to replicate, such as their energy density and their ability to provide high heat. To decarbonize processes that rely on those qualities, we need low-carbon fuels that mimic the qualities of fossil fuels. The energy density of fossil fuels is particularly important in the transportation sector where the weight and volume of the fuel are key. Industrial processes that need very high heat, such as the production of steel, cement, and glass, pose another challenge. It is hard to achieve extremely high temperatures without burning fuel making powering, for example, industrial processes with electricity challenging. (Gross 2020.)

The issue with fossil fuels is that they are incredibly harmful to the environment. When burnt, they release large amounts of carbon dioxide into the air. Fossil fuels are the largest single contributor to climate change, accounting for over 75% of global greenhouse gas emissions and nearly 90% of all carbon dioxide emissions according to the United Nations. (United Nation 2023.)

### 2.1.1 Oil

Oil has been and continues to be the most important energy source globally. It is used to produce gasoline, diesel, and other fuels, as well as being used to heat buildings and produce electricity. It is an extremely energy-dense liquid making it great for transport and being moved by pumps. Oil has been the leading energy source for decades, and for that reason, resources have been used to improve the technology, production, and transport of oil. The developed technology has made oil production and oil use more economical than before, further advancing its position against other energy sources. One of the challenges with more sustainable alternatives is how much heavier they are when used in transportation, and not having an energy grid fit for moving them around. (Gross 2020.)

In 2020, oil accounted for 21% of total energy consumption in Finland. Out of all fossil energy, oil is by far the most used fossil fuel in the country. The share of the energy source has been on the decrease, however, and the consumption of it lowered by 6% in 2020 in comparison to the previous year. The majority of the oil used in Finland has historically been imported from Russia. (Statistics Finland 2021.)

### 2.1.2 Coal

Coal is historically the largest source of electricity generation, but also the largest single source of carbon emissions. Coal supplies over a third of global electricity generation and plays a crucial role in the production of iron and steel. (International Energy Agency 2022a.) In Finland, the share of coal was 10% of the total energy consumption in 2020 (Ketola 2022).

There is a large reserve of coal globally, and building coal-fired power plants is inexpensive in comparison to other fuel processes. The large reserves of coal also mean that the prices of it can be expected to remain stable. On the downside, the energy source is extremely harmful to the environment. Alongside releasing carbon dioxide, burning coal also releases other toxic emissions such as sulfur dioxide, mercury, and nitrogen oxides to the environment. (Morse, Turgeon 2023a.)

The consumption of coal has been steadily declining for a long time already. The coal reserves of Finland were 1.2 million tonnes at the end of December 2021, which is 39% less than the previous year. Recent legislation requires the use of coal to fully end by the spring of 2029 in Finland. Many other countries are also committed to stop using coal, as it is crucial in terms of slowing down climate change. (Yle News 2022.)

### 2.1.3 Natural gas

Natural gas is a fossil fuel that is an extremely popular energy source used for industrial, commercial, residential, and transportation purposes, especially in heating and powering appliances. Like other fossil fuels, natural gas can be burnt for energy. Despite being the cleanest-burning fossil fuel, burning natural gas still releases large amounts of harmful emissions into the atmosphere.

In Finland, natural gas is mainly used in industry, heavy traffic, and by energy companies in heating and combined heat and electricity production. According to Gasum, the consumption of natural gas was 35 TWh in Finland in the year 2021, accounting for five percent of Finland's total energy consumption. (Gasum 2023.) 92% of all the natural gas consumed in Finland in 2021 was imported from Russia (Statistics Finland 2021).

Some of the disadvantages of natural gas, besides the environmental impacts of it, are that the gaseous state of the energy source makes transporting it challenging. For that reason, liquefied natural gas (LNG) has been a popular topic of discussion recently. (Energiamaailma 2023a.) The benefits of LNG are that natural gas in liquid form takes up only 1/600 of the volume of its gaseous state, and it can be easily stored and transported across the world (Morse, Turgeon 2023b).

### 2.1.4 Peat

Peat is not exactly a fossil fuel, but a biomass fuel, as the organic material of peat is not fossilized. That said, it does not count as renewable energy, as the renewal process of it is extremely slow. (National Geographic 2023.) Peat can be used for heat and electricity production in conurbations and industry. Energy peat covered only 2% of Finland's total energy consumption in 2021 and the demand for peat has quickly decreased over the past years. In 2010, the share of peat in our total energy production was 6-7%. (Leinonen 2010, 5.) A big reason for the sudden decrease in demand can be explained by the negative environmental impacts of energy peat, and political decision-making relating to recent environmental and carbon neutrality targets. Peat as a fuel is extremely harmful to the environment and emits 23% more carbon dioxide than coal. (National Geographic 2023.)

Peat has been a controversial topic of discussion in recent years. The harmful environmental impacts of peat are undeniable, but it has been an important energy resource for Finland for years. Peat has had an important role in terms of securing the energy supply in Finland and creating jobs for the citizens. (Sallinen 2022a.)

## 2.2 Renewable energy

Renewable energy is energy from sources that are naturally replenishing. When the sources are utilized sustainably, their reserves do not decrease in the long term. Renewable energy sources used in Finland include water and wind power, solar energy, ground, and air thermal energy, biogas, and biomass fuels. The share of renewable energy in the final energy consumption in Finland is 40%, and the share of it is aimed to be increased to over 50% by the year 2030. The main goals of increasing the share of renewable energy are to lower the amount of carbon emissions produced, increase energy self-sufficiency, and support the development of technology in the energy field. (Ministry of Economic Affairs and Employment of Finland 2023.)

Renewable energy is where modern technology plays a major role. Wind turbines and solar photovoltaic cells, among others, convert solar energy flows into electricity through modern technology. Recently, as renewable energy has become more mainstream and technology has advanced, the prices of it have also dropped. (Gross 2020.) There are currently large investments into building additional solar and wind power production in Finland, and new solar panels and windmills are being installed at a fast rate across the country. That on the other hand means, that electricity production is becoming increasingly more weather-dependent, causing fluctuations in the stability of electricity production. (Hartikainen 2023.)

The challenge with renewable energy is exactly that most of it is weather dependent. The energy grid on the other hand operates in real time. The need for energy doesn’t stop when the wind stops blowing or the sun shining, and for that reason, renewable energy poses a great engineering challenge. Power is generated and consumed simultaneously, and the system needs to stay in balance. Renewable energy makes grid management challenging, as energy from renewable sources is inconsistent, and cannot always be produced at an even rate. (Gross 2020.) In Finland, the grid must have a constant frequency of 50 hertz. The rapid growth of renewable electricity and especially wind power make maintaining the frequency challenging. (Lassila 2023b.)

In terms of solving the potential challenges with renewable energy, investments need to be made into strengthening the energy grid and implementing more demand-response strate-

gies. Power grids that cover a larger area are easier to balance. Demand-response strategies should also be investigated and implemented more, as they can encourage customers to use more power when renewable energy is available and to cut back their electricity usage during peak periods. (Office of Electricity 2023.) One of the most crucial aspects in solving the challenges relating to renewable energy, however, is creating additional and improved power storage technologies.

### 2.2.1 Wind power

Wind turbines are used to turn wind into electricity. Wind turbines can be divided into three main categories depending on where they are installed and how they are connected to the grid. The three categories are land-based wind, offshore wind, and distributed wind. Land-based wind turbines are usually grouped to form wind plants that provide bulk power to the electrical grid. Offshore wind turbines on the other hand capture powerful ocean winds. Distributed wind describes wind turbines located near the place where the energy from them will be used, and they are typically small wind turbines used for residential, agricultural, and small commercial and industrial applications. (Office of Energy Efficiency & Renewable Energy 2023.)

Wind power has become increasingly popular in recent years, as it is cost-effective, renewable, and improves the security of the energy supply. The EU has ambitious targets to increase the use of wind power, especially offshore wind power capacity. Finland has made astonishing increases to its wind power capacity, which is largely thanks to wind power being the most cost-effective electricity generation to build in Finland right now. According to Finnish Wind Power Association, the wind power capacity has increased by 75% in the year 2022 and brought over 2.9 billion investments to Finland. The aim is that eventually, by the year 2030, wind power production would respond to 30% of Finland's electricity consumption. (Finnish Wind Power Association 2023.)

Regarding offshore wind power, the target is to have the first industrial-size offshore wind power projects of Finland in production by the year 2030, and several projects already built in territorial waters and economic zones by 2035. A positive aspect is that as the wind power sector grows, it will create jobs for local companies and create expertise in wind power and especially offshore wind power in arctic conditions. (Huttunen et al. 2022, 210.)

The challenges with wind power are that wind is not always available, causing the production of it to be unstable. The increase in wind power has already brought challenges in the construction of network connections for the wind power plants in Finland, as they require

strengthening of the existing electricity networks. The different schedules set for the projects further complicate the process. (Huttunen et al. 2022, 55)

### 2.2.2 Solar energy

Solar power is a renewable and clean energy source. It works by capturing the energy from the sun's rays and converting it into electricity using photovoltaic (PV) cells. The electricity can then be used directly, stored in batteries, or converted into alternating current (AC) electricity. Solar panels can be placed anywhere with abundant sunlight (Aggarwal 2023.)

While solar power has many benefits, including reducing greenhouse gas emissions, decreasing dependence on fossil fuels, and lowering electricity costs in the long run, it does have limitations. Some of the challenges with solar power are its high upfront costs and the fact that it is intermittent. One major downside with solar energy (common with wind energy), is the scarcity of materials and minerals needed to manufacture the solar panels and solar technology. There is a risk we do not have enough of those materials to respond to the demand in the long term. Mining the minerals can also have negative impacts on the environment as well. (Crail 2023.)

The use of solar power is rapidly growing around the world as more people recognize its potential to reduce environmental impact and provide sustainable energy solutions. In 2021 solar power accounted for approximately 0,4% of Finland's total energy production. Currently, there are multiple new solar power plant projects underway, and the growth of solar energy will be exponential. Many of the projects in development are industrial solar power plants, meaning that when ready the single plant will be able to produce tens of megawatts of energy per day. According to a recent estimate made by Fingrid, there could be 7000 megawatts worth of solar power plants in Finland by the year 2030. To compare, the current production capacity is estimated to be 600 megawatts. The Finnish government has set a target of producing 4% of the country’s energy from solar power by the year 2025. (Lassila 2023a.)

### 2.2.3 Biomass energy

Biomass refers to any organic matter, such as wood, crops, or animal waste, that can be used as a source of energy. Finland has a long history of using biomass for heating and electricity generation, and it is a key component of the country's renewable energy strategy. (Ministry of Agriculture and Forestry of Finland 2023.)

In Finland, the most significant biomass is wood. There are several ways in which it can be used for energy production, including: 1. Combustion: Wood can be burned to produce heat, which can be used for space heating or to generate electricity. In the process, wood is burned in a furnace or boiler to produce steam, which drives a turbine to generate electricity. 2. Gasification: In this process, wood is heated in the presence of oxygen to produce a gas mixture known as syngas. Syngas can be used to generate electricity or as a fuel for heating. 3. Pyrolysis: This process involves heating wood in the absence of oxygen to produce bio-oil, which can be used as fuel for heating or to generate electricity. (Morse, Turgeon 2022.)

A positive aspect of wood-based energy is that it is carbon neutral, as the carbon dioxide released during combustion is balanced by the carbon dioxide absorbed by the trees before getting used for energy. In 2020, wood-based energy sources were the most significant source of renewable energy consumption in Finland. 74% of the total renewable energy consumption was formed from wood-based energy sources. (Valtioneuvosto 2022.) Of the total energy consumption, wood fuels covered 28% in the same year, 2020. A major share of food fuels is derived from the by-products of the forest industry. (Ministry of Agriculture and Forestry of Finland 2023.) In addition to wood, Finland produces biomass from agricultural waste, biogas, and solid waste.

## 2.3 Nuclear energy

Nuclear energy is not renewable but produces little carbon emissions, making it in that sense cleaner than many other energy forms. Finland has four nuclear power plant units in electricity production. Two of the power plants are in Olkiluoto, and two are in Loviisa. The fifth nuclear power plant of Finland is located in Olkiluoto as well. (Stuk 2022.) The existing power plants have valid operating licenses until 2038, and the newest power plant unit Olkiluoto 3 is expected to be used until the 2080s. Of Finland's total electricity production, the share of nuclear energy is about 30%. Nuclear power plays an important role in facilitating green transition as it produces very little carbon emission but can produce base load power with steady production efficiency, which is uncharacteristic of most low-carbon electricity. (Huttunen et al. 2022, 211.)

The issue with nuclear energy is the highly radioactive nuclear waste it produces. Nuclear waste is usually stored underwater for the first five years and can remain radioactive and harmful to humans for the next thousands of years. The final nuclear waste disposal facilities need to operate for decades longer than the power plants, as they must be in operation until all the nuclear waste and demolition waste from the power plants have been disposed

of. That means that the waste management of the power plants currently in use will extend as far as the 2120s. (Huttunen et al. 2022, 211.) A positive aspect is that Finland has made excellent progress and come up with innovative ways to dispose of radioactive waste. The world's first geological permanent nuclear waste site Onkalo is nearly ready and expected to get a final license for waste disposal in 2024. (Yle News 2023) The Head of the International Atomic Energy Agency's Waste and Environmental Safety Section Anna Clark gave Finland acknowledgment for its safe radioactive waste management program and for seeking continuous improvement through the ARTEMIS peer review. (International Atomic Energy Agency 2022.)

Alongside conventional nuclear reactors, small nuclear reactors seem like a potential new energy source in the future. At the time of this thesis, there are no small nuclear reactors in Finland, and no serious plans to build one yet. Small nuclear reactors becoming a part of our energy mix would require the development of global and national legislation to enable cost-effective serial production of SMRs. It is worth mentioning, however, as it seems unlikely that additional conventional reactors would be built in the upcoming years. (Rantakaulio 2020a.) The need for stable low-emission electricity will remain, and small reactors could be an interesting opportunity, as there is talk that SMRs (small modular reactors) could be built in factories and then transported to the site and connected to the rest of the infrastructure. SMRs have a smaller level of output, which makes them perfect for energy production for targets where the energy demand is smaller, such as more isolated locations. Another use for SMRs would be in meeting the needs of hydrogen production. (Rantakaulio 2020b.)

## 2.4 Hydrogen

Hydrogen is a versatile and clean energy carrier that has the potential to play a significant role in transitioning to a low-carbon energy system. It has gained increasing attention in the energy sector as a potential solution to address various energy challenges. Hydrogen can be produced from almost all energy sources and can be used in many ways, as a raw material, fuel, energy carrier, and energy storage medium. Currently, the use of hydrogen in oil refining and chemical production is mostly covered by hydrogen from fossil fuels. When produced from renewable sources such as wind or solar power, however, hydrogen can be considered a clean and sustainable energy carrier. Eventually, the hope is that emission-free hydrogen can replace the use of fossil energy sources. (International Energy Agency 2022b.) Most of the world's hydrogen is bound to water and can be separated from it with an electric current. Hydrogen on the other hand can also be used to produce electricity, in a process that produces water. (Blom 2021.)

One of the main advantages of hydrogen is its versatility. It can be used as a fuel for transportation in combustion engines or to power electric vehicles. Fuel cell vehicles powered by hydrogen emit only water and heat as by-products, which significantly reduces greenhouse gas emissions and improves air quality when used instead of traditional fuels. Hydrogen can also be used in industrial processes, for example in the production of chemicals and steel, and be used as a fuel for power generation. The emissions formed as a result are much lower than those from fossil fuels, making hydrogen a cleaner option for power generation. Perhaps most importantly, hydrogen can also be used to store and deliver energy. As an energy carrier it could be an excellent alternative to energy storage and transport, therefore working together with system integration. Developing renewable hydrogen is a priority for the EU, and the European Commission has proposed to produce 10 million tonnes of renewable hydrogen by 2030. It aims to also import the same amount, by the same year. (European Commission 2023a.)

The infrastructure for hydrogen refueling stations is still developing, and the cost of producing and distributing hydrogen is currently higher than that of gasoline or diesel. Currently, emission-free hydrogen is not economically competitive without significant support. Another issue with hydrogen is its highly flammable nature, which causes it to require close attention in the production, use, and transport of it. (Huttunen et al. 2022, 192.)

Hydrogen has the potential to play a significant role in the transition to a low-carbon energy system. Despite the challenges, according to the International Energy Agency (IEA) and Dr. Fatih Birol, clean hydrogen is currently enjoying unprecedented political and business momentum, with the number of policies and projects around the world expanding rapidly. An increasing number of countries have policies that directly support investment in hydrogen technologies. The reports conclude, that now is the time to scale up technologies and bring down costs to allow hydrogen to become widely used. (International Energy Agency 2022c.)

# 3 Finland’s energy policy

## 3.1 Finland’s energy policy in the past

Every few years when a new government is elected, the ministry prepares a new energy- and climate strategy, that typically works as an action plan for the energy sector. The energy policy and the goals and contents of the energy strategy are affected by the outcome of the governmental elections and tend to slightly reflect the power dynamics between different political parties and the government formed. The strategies are formed in coordination with the Ministry of the Environment and the Ministry of Agriculture and Forestry. This chapter looks at the energy strategy (the Government's energy policy report to the parliament) of 1997, the national climate and energy strategy of 2008, and the current climate and energy strategy of 2022.

## 3.2 1997

Perhaps somewhat surprisingly, the key points and ideologies in the national energy strategy published in 1997 were very similar to what we are seeing in the newest Marin government's energy strategy. Despite the world and environment in which the decisions were made being very different back in 1997, many of the key issues in the energy strategy have remained the same. The strategy focuses on sustainability, ensuring the security of the energy supply, and having competitive pricing. 25 years ago, the European energy market was still mainly divided into national energy markets and was only slowly starting to become more international. The internationalization and opening of energy markets were new starting points for energy policy and the energy strategy at the time. Sustainability was another starting point for the energy strategy. (Valtioneuvosto 1997, 2476-2477.) It was understood that energy is a necessity for a working society, which was why the Council of State committed to ensuring the security of the supply of energy and aimed to not use any means of control that would lower Finlands’ competitiveness (Valtioneuvosto 1997, 2476).

In 1997, the main goals, but also challenges seen ahead were needing to ensure the availability of internationally competitively priced energy, while simultaneously managing to lower the number of carbon emissions produced. To complicate the equation, those goals were supposed to be reached while it was forecasted that the consumption of energy would increase by 1,4 times the amount used in 1997, and the production double, by the year 2025. This would naturally result in producing more carbon emissions. In other words, the end goals were conflicting. It was crucial that energy policy would be handled with a long-

term strategic approach if the goals wanted to eventually be reached in reconciliation. (Valtioneuvosto 1997, 2481.)

To answer to the rising demand for energy, the council of State stated that the share of sustainable energy and natural gas must be increased in the total energy supply. The use of other fossil fuels besides natural gas was to be decreased. Creating free competition in the EU's energy market and joining Russia in the European energy market were seen as important steps that needed to happen for Finland to successfully implement its energy strategy, and deal with the upcoming challenges. Further increasing the use of natural gas meant that the security of the gas supply needed to be secured. The dependency on the single-producer natural gas market also needed to be significantly reduced, which would mean getting Finland joined to the European gas network. Conditions for the implementation of the project were already under investigation at the time. Another key issue, and goal, was to expand Russia's gas transmission network to central Europe, which was thought could be done through Finland. Russia had already stated its willingness to export natural gas and had the means to fulfill the rising demand for gas in Europe. (Valtioneuvosto 1997, 2478-2479.)

While connecting Russia's gas transmission network to Europe was already under investigation and the project was seen as promising, it was understood that whether the project would eventually get the green light or not was out of Finland's hands. Planning to rely on natural gas heavily in the future could become dangerous if the project came to a stall and the security of the supply of natural gas could not be secured. Taking matters to lower energy consumption, using a broad range of different energy sources, and prioritizing the development, use, and export of new technology were therefore seen as crucial in ensuring that there will be enough energy supply to meet the demand while simultaneously managing to lower the carbon emissions produced. (Valtioneuvosto 1997, 2479.) Many politicians and people thought that nuclear energy would be the best solution to increase the supply of energy, instead of natural gas. It had already been decided, however, that nuclear energy would be out of the realm of discussions in 1997. Either way, it was also very much unsure whether there would even be a constructor for a new nuclear plant, if the time came, due to the project being a risky investment for constructors. (Valtioneuvosto 1997, 2485.)

It was known that in the purchase of energy, diversity of sources, and sufficient self-sufficiency were crucial. The use of coal was aimed to be lowered, and eventually completely stopped, and the use of natural gas and wood on the other hand increased. Wind- and solar power were realistically not going to be the answer to Finland's rising energy needs but could be used to answer smaller-scale individual and local energy needs. The development,

use, and export of new technologies were something that needed to be supported and prioritized in the energy sector. Resources were planned to be used in the research and development of biofuels and bioenergy. (Valtioneuvosto 1997, 2480.) While a lot of hope had been put on natural gas being the answer to the rising demand for energy, having an energy production system based on as many primary energy sources as possible was crucial. No energy sources wanted to be ruled out prematurely or terminally. (Valtioneuvosto 1997, 2478.)

## 3.3 2008

The climate and energy strategy published in 2008 was more extensive and detailed in content in comparison to the previously discussed 1997 energy strategy. When reading the new strategy, it is easy to notice two major developments from 1997. The first development is, how heavily the discussions in the strategy revolve around the European Union. The second change is perhaps less evident, but still interesting. It is that the conversation around climate change had developed from focusing on the prevention of climate change, to also include adaptation, and damage control of already made irreversible changes to our environment. It was understood that climate change cannot be fully stopped anymore, but rather needs to be controlled. The risk of the worst consequences needed to be reduced as much as possible. As climate change is a global issue, it was clear that solving/controlling it, therefore, needed international measures. For that reason, the Kyoto Protocol, European Climate Change Programme I (ECCP I), ECCP II, and other international climate agreements were considered important aspects when moving forward and acting against climate change. A lot of the discussion around Finland's climate targets etc. relates to these international agreements, and they often get referenced in the national energy strategy. Unlike previously, in 2008 the climate and energy strategies were no longer separate. The joining of the two strategies was a natural step to take, as the energy industry is the largest polluter in the world. (Ympäristöministeriö 2008, 25.)

The starting point in the 2008 energy strategy was that our society had become even more dependent on energy. Having reliable energy sources and slowing the growth of overall energy consumption were key topics in the new energy strategy. Ensuring the security of the availability of energy over the upcoming years and increasing the use of sustainable energy was at the heart of things once again. Finland's energy policy had become a part of what was now a much more international operating environment, so naturally, when making decisions and drawing up the new energy policy of Finland, the global environment and

especially the EU played a major role. Many of Finlands' goals and actions regarding sustainability are based on the EU's goals and actions for its member states. (Ympäristöministeriö 2008, 7-8.)

In terms of energy sources, natural gas had become much less interesting and desirable than it was in 1997, as the gas pipe from Russia (Nord Stream) was decided to be built on a sea route across the Baltic Sea directly from Russia to Germany. That meant, that the hopes of getting Finland joined to a European gas network and securing the supply of natural gas, would not come true as originally hoped. Nuclear energy had now become the more interesting and promising option, and it was hoped that the government would decide about building additional nuclear power plants soon. Nuclear energy was specifically wanted and needed to ensure the availability of electricity in Finland. (Valtioneuvosto 2008, 49-50.) Relating to sustainable energy, the world market price of oil, coal, and natural gas had increased sharply in the international market, which changed the market to be more favorable for renewable energy resources as well. (Valtioneuvosto 2008, 11.) Biofuels are a big topic of discussion in the strategy, as it was recognized that a major portion of all emissions produced is formed by proxy from transportation. For that reason, biofuels were seen as a potential, yet uncertain solution for reducing emissions in the future. The use of sustainable energy was further encouraged by developing the national energy taxation to better regard the environmental impact of different energy methods. (Valtioneuvosto 2008, 56.)

In the 1997 energy strategy, it was discussed how technology and innovations in the energy sector should be supported and prioritized. In the 2008 strategy, it was noted that in addition to developing the technology and innovations as mentioned in 1997, actions relating to education, advisory, and communications in the energy sector needed to also be paid close attention to. Energy saving was considered to potentially play a crucial role in reaching the sustainability goals set for Finland. It is stated in the energy strategy that without new actions the total energy consumption in Finland will continue to grow. Finland had already done a lot to increase energy efficiency, but there is still a lot of potential left for additional energy savings. (Valtioneuvosto 2008, 58.) In the area of energy saving, innovations play an important role.

An important action and target mentioned in the 2008 energy strategy was reducing the number of emissions produced by 5% in comparison to the year 1990. The reduction needed to be done by the year 2012. The EU emissions trading system (EU ETS) was also a new addition that plays a crucial role in lowering carbon emissions. It enables lowering carbon emissions cost-efficiently, as the emission reduction can be done in the market

where it is the most cost-efficient. The EU ETS will be discussed in more detail in the later chapters.

The goal of the strategy was to stop the growth of energy consumption and increase the share of renewable energy in total energy consumption. The share of renewable energy was supposed to be 38% of the final consumption of energy by the year 2020 according to the obligations set by the EU. Reaching the goals requires new policy actions and increasing energy efficiency. Opposed to the views in 1997, it was now seen that renewable energy would be the answer to the rising demand for energy. Increasing energy self-sufficiency was also important. (Valtioneuvosto 2008, 8-9.)

## 3.4 Statistics

For the past two decades, Finland has steadily invested in renewable energy production and decreased the share of fossil fuels in the gross available energy, as showcased in the tables below.

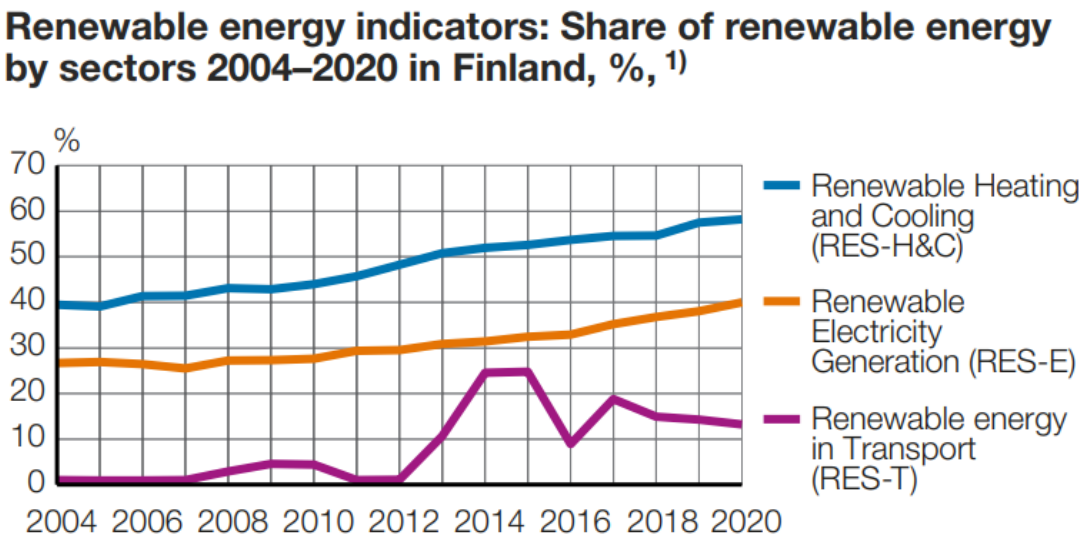


Figure 1 Renewable energy indicators. (Eurostat 2023.)

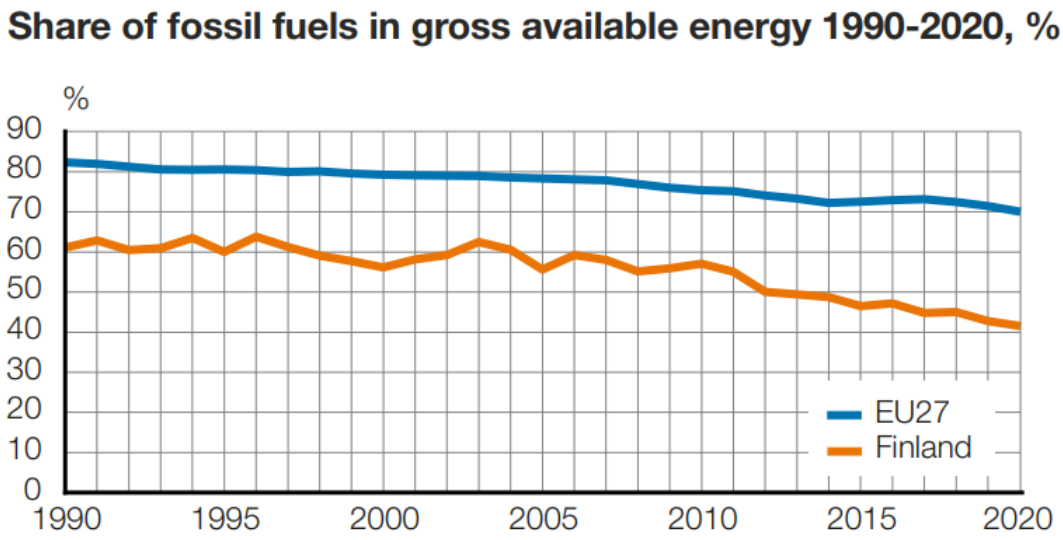


Figure 2 Share of fossil fuels in gross available energy. (Eurostat 2023.)

## 3.5 The current state of Finland's energy policy

Sanna Marin's government's climate and energy strategy "Carbon neutral Finland 2035 – national climate and energy strategy" was released in September 2022. As the name states, the focus of the strategy and its policy actions are in meeting the climate and energy goals set by the EU for the year 2030, and the carbon neutrality 2035 goal of Marin's government program. The strategy is over 200 pages long and extremely extensive. It considers issues such as gender equality, social impacts, regional impacts, and Sami people's rights. Some of the key objectives of the 2022 energy strategy are phasing-out Russian fossil fuels, promoting non-combustion heating, and electrifying the energy system.

It comes as no surprise that sustainability is at the heart of the 2022 energy and climate strategy. It is stated in the strategy that around 80% of all greenhouse gases causing global warming result from the production and consumption of energy. For that reason, the strategy heavily focuses on promoting energy efficiency and clean energy sources. The goal is to move towards a carbon-neutral, and down the line, a carbon-negative society in a cost-effective, efficient, and sustainable manner. (Huttunen et al. 2022, 10.) The three main factors at the core of this energy policy, and our national energy systems are 1. Cost efficiency. The energy system needs to be cost-efficient to enable the growth of the national economy and the competitiveness of Finnish companies in the global market. 2. Sustainability. 3.

Reliability. To achieve those three objectives, we need to have an energy market that functions efficiently. A predictable and stable operating environment is needed to ensure investments in the energy sector, and the development and global export of Finnish technology. Both factors are perquisites for making changes to our energy sector, energy systems and moving towards a more sustainable future. (Huttunen et al. 2022, 10-11.)

When it comes to reaching the goal of becoming carbon neutral by 2035, greenhouse gas emissions need to be equal to removals caused by carbon sinks. Reducing emissions, increasing carbon sinks, promoting renewable energy, and promoting energy efficiency are actions listed in the strategy to reach the carbon neutrality goal. Emissions trading, hydrogen, and electro fuels are some of the tools for getting there. Finland has stated that its target is to increase the share of renewable energy to at least 51% of the total final energy consumption. (Huttunen et al. 2022, 18.) In 2022 it was stated that 150 million euros would be annually allocated to demonstration projects concerning new technologies, and on top of that, sufficient aid would be budgeted for smaller renewable energy- and energy efficiency projects. (Huttunen et al. 2022, 29) It is stated that renewable transport fuels, new sustainable raw materials, production of bioenergy, and wind power construction will be promoted. New technology is needed to develop and improve renewable raw material and energy production. Innovation, development, and especially the export of advanced clean technology is crucial in the sense of creating new jobs in Finland and increasing Finland's carbon handprint. Finland has strong expertise and is one of the leading countries in the world in the circular economy, high-added-value bio-products, sustainable energy systems, and environmental solutions. This expertise should be utilized to create and export new technology and energy products.

While actions to reduce carbon emissions produced are taken, carbon sinks will also be increased and strengthened. The land use sector has been paid special attention to in the new energy and climate strategy. The strategy focuses on finding solutions in the agriculture sector to lower carbon emissions produced and to increase carbon capture. For the first time, there was a growth target set for carbon sinks and stocks, which applies to areas managed by both business and nature services. (Huttunen et al. 2022, 28.) Carbon capture plays an important role in many ways, one of them being that it is currently the cheapest way to deal with emissions from heavy industries that require combustion.

Some special themes in the strategy are electrification and system integration. The industry sector, heating of buildings, and transport sector are all aimed to be electrified. The electrification of the energy system and the use of system integration are the keys to cutting emissions, especially in sectors where reducing emissions is difficult and is done mostly through

carbon capture and emissions trading systems. According to the strategy, electrification could mean an increase of 100 percent in industrial electricity consumption and an increase of more than 50 percent in Finnish electricity consumption by 2050. What that means is that increasing low-emission electricity production capacity and strengthening the main grid are crucial in moving forward (Huttunen et al. 2022, 23) System integration is one of the keys in electrification and phasing out fossil fuels. To ensure the security of supply and the functioning and efficiency of our energy systems, we need to strongly link the different energy systems to each other. We also need more green electricity than ever before, which means investments in wind power and other sustainable energy production. Increasing weather-dependent electricity production causes investments t in strengthening the energy grid and electricity storage needing to be made. Dealing with long cold and windless periods will require flexibility in both, electricity production and consumption. The other issue is that our energy system cannot handle high volatility. For that reason, we need to have a strong energy grid and be able to store electricity (Huttunen et al. 2022, 189).

Hydrogen and power-to-X processes are some of the most promising potentials when it comes to system integration. (Huttunen et al. 2022, 191.) In terms of system integration, hydrogen can play a massive role in the ways we can store and transport energy. Hydrogen can be used to balance the energy network, especially electrical power networks. In 2021, the Finnish hydrogen network was established. The network aims to make Finland a global leader in developing and offering hydrogen solutions globally. At the time of this paper, over 50 hydrogen companies have joined the network (Huttunen et al. 2022, 192.) While hydrogen is an exciting and promising player in the energy sector, it does come with its challenges. The storage and transfer of it are tricky for a few reasons. Hydrogen is highly flammable, liquified at only -253 Celsius degrees, and as gaseous compound steeps through normal steel. (Huttunen et al. 2022, 196) Clean production of hydrogen and transformation back into another form of energy also requires energy, which is lost in these transformations. For that reason, hydrogen should be used in situations in which electricity or other emission-free energy cannot be used to provide the required energy. (Huttunen et al. 2022, 192)

All in all, to secure and enhance the operation of our energy systems, the different systems must be strongly linked to each other. System integration should be done with calculation and a long-term plan, and the share of renewable electricity and energy production increased. Simultaneously, carbon sinks need to be increased and energy-saving schemes and technology implemented. Hydrogen holds a lot of potential in many ways, but especially as an energy carrier it could be an excellent alternative to energy storage and transport working together with system integration. Ensuring the functioning of the energy market, energy delivery reliability and security of supply are a prerequisite for the success of the

energy transition required to reduce emissions. Phasing out Russian fossil energy can be done through green transition, which is also a perquisite for reducing greenhouse gas emissions. Through the actions in the strategy, Finland is on the road to becoming carbon neutral by 2035.

## 3.6 The significance of the EU

The European Union plays an important role when it comes to political decision-making in Finland, including the decisions made regarding energy policy. As a member state of the European Union, Finland is subject to the EU's energy policy framework. The EU sets common objectives for all its member states but does allow some national flexibility in implementation.

The European Union (EU) has its roots in several treaties signed in the aftermath of the Second World War. The initial idea was to foster economic cooperation, based on the idea that countries that trade with one another and become economically interdependent are more likely to avoid conflict. What started as an economic union has since evolved into an organization covering many different policy areas from climate, environment and health to external relations, security, justice, and migration. The EU’s main economic engine is the single market, but it aims to follow suit in other areas such as energy, knowledge, and capital markets. The goal is to ensure that Europeans obtain the maximum benefit from these resources as well. (European Commission 2023b.)

The energy policy of the European Union is currently being developed under the heading of Energy Union. Energy Union is an energy policy program, that looks at the EU’s energy policy overall. It was founded in 2015, with the purpose to ensure that EU citizens and businesses are provided with affordable, secure, competitive, and sustainable energy. (Eurooppatiedotus 2015.) The Energy Union is coordinated with other policy areas like transport, research and innovation, digitalization, circular economy, and sustainable financing (European Commission 2022).

Some of the motives behind setting up the Energy Union in 2015 were the high demand for energy production in Europe, and the EU being the biggest energy importer in the world. At the time the Union was founded, as much as 53% of all the energy used in Europe was imported from outside the continent at 400 billion euros. On top of that, multiple member states (including Finland) were relying on a single non-EU supplier for gas import, which was exposing the countries to energy supply disruptions and price fluctuations. What further

sped up the implementation of the Energy Union was the crisis in Ukraine that happened in 2014, and the strain and insecurity it caused in the energy sector. (Eurooppatiedotus 2015.) 6 years later however, in the year 2021, even a higher percentage of 56% of the energy in the EU was still being imported. The majority of the imported energy came from Russia. While the statistics sound worrisome, the dependency rate on imported energy is on the fall when compared to previous recent years. Despite that, it is safe to say that the goal of improving energy production rates and self-sufficiency in the EU has not been reached to a satisfactory level. (Eurostat 2023a.)

The Energy Union has the goal to develop energy security, the internal energy market, energy efficiency, and a low-carbon economy in the EU. In an Energy Union, member states coordinate and cooperate with their neighbors when developing their energy policies. To achieve the goal of providing EU consumers with secure, sustainable, competitive, and affordable energy, the energy system of Europe needs to be developed. The European Commissions' vision of an Energy Union has all along been one where member states depend on each other to deliver secure energy for their citizens, and there would be an integrated continent-wide energy system where energy flows freely across borders. The continent-wide integrated energy system is thought to be needed to create competition, lead to greater market efficiency, and to produce affordable prices for consumers. The Energy Union is based on solidarity and trust, and the goal is to have an Energy Union that speaks with one voice in global affairs. The transformation of the energy system continues to this day, and the EU and its member states adapt and reshape the energy and climate strategies regularly. (European Commission 2015, 2-3.)

## 3.7 The five dimensions of the Energy Union

The Energy Union has five closely interrelated dimensions, that are designed to bring greater energy security, sustainability, and competitiveness in the EU. The five dimensions of the Energy Union and their impacts on Finland are:

*1. Security, solidarity, and trust*: The European Commission stated in 2014 that the EU is vulnerable to external energy shocks. The starting point for the Energy Union was that joint approaches in the energy field can make all parts of the EU stronger, in case of supply shortages, disruptions or other issues. (European Commission 2015, 4) It is stated that energy sources needed to be diversified, alongside diversifying suppliers and routes to ensure secure and resilient energy supplies to Europe. In terms of energy sources, especially natural gas supplies are aimed to be diversified. One of the key actions in that regard is establishing liquid gas hubs with multiple suppliers, especially to Northern Europe. When

the Energy Union was founded, the potential of liquefied natural gas (LNG) was explored and increases in LNG trade were aimed to be made. To diversify the energy supply, the Commission also updated and enhanced the requirements regarding nuclear installation projects. (EUR-Lex 2023.)

The importance of domestically produced energy is underlined, especially domestically produced renewable electricity, and unconventionally produced oil and gas. It was noted in 2015 that multiple member states have inadequate security of electricity supply frameworks and their approaches to assessing the security of electricity supply were outdated and inconsistent. It was going to be addressed by the European Commission. Cross-border flows, variable renewable production, demand response and storage possibilities were going to be paid close attention to. (EUR-Lex 2023.)

When the Energy Union was created in 2015, an emphasis was placed on energy security. That meant that Oil Stocks Directive was adapted, and member states were obligated to build up and maintain minimum stocks of crude oil and petroleum products. In situations of tight supply member states could rely on their neighbours. Stronger cooperation in case of supply distributions in the gas sector was needed, and solidarity especially in times of supply crisis needed to be strengthened. The Commission was taking action to revise and improve regulations regarding them. The EU has taken action to develop its partnerships with Norway, the second largest supplier of crude oil and natural gas, as well as developing its partnerships with the U.S. and Canada.

The key drivers of energy security are completing the internal energy market and more efficient energy consumption. The EU also has measures to promote energy infrastructure projects, such as the Connecting Europe Facility, to improve cross-border energy connections. Solidarity in energy matters is at the heart of the Energy Union. (EUR-Lex 2023.)

*2. A fully integrated internal energy market:* At the time of the founding of the Energy Union, Europe's energy system was underperforming, and the market design was not leading to sufficient investments. Funding was going to be improved and their impact maximized to ensure investments in energy infrastructure projects. The biggest starting point to working towards a fully integrated internal energy market was the full implementation and strict enforcement of existing energy legislation. It was understood that there is no point in developing new policies and approaches on weak foundations. Alongside implementing existing energy legislation, the Commission prepared an ambitious legislative proposal to redesign the electricity market and link wholesale and retail. The legislative proposal was going to increase the security of supply and make the electricity market better adapted to the renewable energy transition.

The flow of electricity and gas across different transmission systems was going to be harmonized to ensure better functioning cross-border energy markets. There needed to be more interconnections between member states to encourage the fast and free flow of energy. In terms of market integration of renewable electricity generation, electricity grids need to be evolved significantly. That included expanding the possibilities for super grids and new storage technologies. The maintenance of the new and essential infrastructure was to be prioritized.

Greater competitiveness between suppliers was required to ensure affordable prices. The EU has implemented measures to promote competition and liberalize its energy markets. This includes measures such as unbundling of energy production, distribution, and supply activities to promote competition and the establishment of a single EU energy market to enhance market integration and transparency. (EUR-Lex 2023.)

In terms of interconnection level, Finland is already above the level required by the EU and aims to keep the interconnectivity above 15% in 2030. (European Commission 2023c.)

*3. Energy efficiency:* The EU aims to reduce energy consumption and improve energy efficiency in many sectors, including buildings, transport, and industry. The Energy Efficiency Directive establishes binding targets for member states to achieve a 32.5% reduction in primary and final energy consumption by 2030. Finland is also required to reach these targets. The measures included in them are related to promoting energy-efficient building standards, promoting energy-efficient appliances, and supporting energy audits and management systems. The directive also requires member states to establish measures to reduce their annual energy consumption by an average of 4.4% by 2030. The EU has also agreed to reduce its dependence on Russian fossil fuels rapidly, well before 2030, by accelerating energy savings. (Ciucci 2022.)

A lot of the work regarding energy efficiency is done on a national, regional, and local level, but the European Commission creates a framework for the progress. There are strong measures already put in place by the EU to make its member states more efficient in energy consumption. One of the most important aspects of becoming more energy efficient is decarbonizing the transport sector in the EU. Transport represents over 30% of final energy consumption in Europe, so increasing fuel efficiency and bettering traffic management are crucial. Electrifying the transport sector is also important in the sense of breaking the oil dependency. (EUR-Lex 2023.)

*4. Climate action and decarbonizing the economy:* The EU is committed to increasing the share of renewable energy in its overall energy consumption. The EU introduced The Renewable Energy Directive in 2009, which is a legal framework for the development of renewable energy, and it supports cooperation across the member states. The Renewable Energy Directive sets a target for the EU to achieve at least 32% of renewable energy consumption by 2030. This includes measures such as promoting the use of renewable sources like wind, solar, hydro, and biomass and supporting research and development in renewable technologies. (European Commission 2023c, 1.) On a national level, Finland's target set by the EU for 2030 for non-ETS greenhouse gas emissions is -39% compared to 2005. The target is set in the Effort Sharing Regulation (ESR). The EU's energy policy is closely aligned with its climate action objectives. The EU has committed to reducing greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels and achieving climate neutrality by 2050. The energy policy measures, such as promoting renewable energy and energy efficiency, are part of the EU's broader strategy to combat climate change. (European Commission 2023c, 2.)

*5. Research, innovation, and competitiveness:* The EU promotes innovation in the energy sector through research and development programs, such as Horizon 2020 and the European Innovation Council. These programs support research, innovation, and demonstration of new technologies in areas such as renewable energy, energy storage, and smart grids. It is crucial for the EU to have a strategy for research and innovation, as the Energy Union should lead the next generation of renewable technologies and storage solutions. (European Commission 2023c.)

The goal of the Energy Union is to take an integrated approach to create synergies to achieve the maximum result from all investments across the EU. What it means, is that member states work together to coordinate efforts and deliver results. There should be more effective links between research and industry to bring new technologies to the market in the EU. Besides developing next-generation renewable technologies and facilitating the energy transition through smart grids, smart appliances and new sustainable transport systems, there is also an emphasis placed on carbon capture and storage. (EUR-Lex 2023.)

On a national level, Finland has made general directions and budgets for research, innovation, and competitiveness, but has received feedback from the EU that the final plan needs specific and forward-looking objectives and targets. (European Commission 2023c, 1-3)

## 3.8 The EU Emissions Trading System

The European Union Emissions Trading System (EU ETS) is the world's largest carbon market, and perhaps one of the most important of the EU's policies against climate change. Set up in 2005, it is also the world's first international emissions trading system. The EU ETS makes it possible to lower carbon emissions cost-efficiently, as the emission reduction can be done in the market where it is the most economical. It is a key tool in combatting climate change and plays a significant role in the energy sector as well.

The EU ETS works on the principle of cap-and-trade. A cap is set on the total amount of greenhouse gases that can be emitted by participating installations, such as power plants, factories, and airlines in the EU. The cap is gradually reduced over time, so that total emissions fall, and the EU's emissions reduction targets would be reached. The participating installations are issued allowances that represent the right to emit a certain amount of greenhouse gases. These allowances can be traded with one another, allowing for a market-based approach to reducing emissions. After each year, an operator must surrender enough allowances to cover its emissions or pay heavy fines. If an installation emits more greenhouse gases than it has allowances for, it needs to purchase additional allowances on the market. If an installation on the other hand reduces its emissions, it can keep the spare allowances for future needs or sell them excess to another operator that is short of them. This creates a financial incentive for installations to reduce their emissions and invest in cleaner technologies. (European Commission 2023d.)

The EU ETS covers emissions from more than 11,000 installations in the power and industrial sectors in 31 countries, including all 27 EU member states plus Iceland, Liechtenstein, and Norway. It also includes emissions from aviation, from flights between airports located in the European Economic Area. The gases EU ETS covers are carbon dioxide, nitrous oxide, and perfluorocarbons. (European Commission 2023d.)

The EU ETS has faced some criticism, with some arguing that the cap has been set too high, leading to a surplus of allowances and a low carbon price. It also does not include all emissions, and for example, the emissions from maritime transport have only recently been included in the emissions trading scheme. The EU has taken steps to address the lacks by introducing a Market Stability Reserve, which aims to reduce the surplus of allowances and stabilize the carbon price. The EU ETS will also be improved as a part of the Fit for 55 package. Finland has stressed the importance of strengthening emissions trading. (Finnish Government 2021.)

# 4 The green transition

The goal of green transition is to have a sustainable economy that relies on low-carbon solutions that promote circular economy and biodiversity. It supports the structural adjustment of an economy and helps to build a sustainable welfare society. In practice, green transition means investments in clean energy production and phasing out fossil fuels, investments in biodiversity and circular economy, and electrifying the transport sector. (Ministry of the Environment 2023.) The goal of the green transition is to make our society carbon neutral, and eventually carbon negative. The concept of a green economy has gained increasing acceptance, as it provides a response to multiple recent crises, such as climate and economic crises. The green transition and green economy offer the promise of growth while protecting ecosystems and moving away from systems that allowed and at times generated environmental and economic issues. (Ocampo 2023, 4.) In developed countries like Finland, the green transition should be an incentive for new innovative activities that create more jobs than traditional sectors and increase energy security and efficiency in the industry. The green transition will bring new skills and technologies that help to speed up the transition. (Cosbey 2023, sivu 41) The Sustainable Growth Programme for Finland aims to help build up those skills by supporting research, training, and education and through it improve the competitiveness of Finland's export industries. The key goals in Finland are making the country a world leader in hydrogen, circular economies, and emission-free energy systems. (Ministry of Finance Finland 2023.)

What makes the green transition necessary is the fact we are currently overconsuming natural resources. Energy production is one of the biggest causes of overconsumption of natural resources, as currently a large portion of our energy consumption is being fulfilled by fossil fuels, the production of which destroys habitats in various parts of the world and is speeding up climate change. On a local level, the green transition also contributes to fighting against pollution of air, soil, and water. (Ministry of Finance Finland 2023.)

Replacing traditional fossil fuels with sustainable alternatives can generate economic benefits by opening new export markets. International trade on the other hand is a powerful driver of growth. There will be opportunities in new markets for biofuels and renewable energy technologies, and Finland should use its strong expertise in the fields to create export opportunities. (Cosbey 2023, 41.) The easiest place to start the green transition is electrification. Ensuring sustainable electricity production in all conditions is the key to green transition, and important for our society in general. The end goal is to transition to more weather-dependent energy production, and nuclear power will play a role in facilitating the transition. (Huttunen et al. 2022, 210.) Electrifying the energy system requires major investments,

which can only be made if the operating environment is stable and predictable enough. Some of the major areas and infrastructures that require investments are emission-free heat production, additional electricity production, and ensuring the functioning of the electricity system. (Huttunen et al. 2022, 10.) In Finland, a billion euros of funding has been allocated to green transition through the Sustainable Growth Programme. The funds come from the EU and have been allocated to RDI activities that support the green transition, investments in research and innovation infrastructure that support sustainable growth and digitalization, as well as to energy system projects, circular economy projects, and low-carbon projects in industry. (Huttunen et al. 2022, 62.) On top of the billion-euro EU funding, additional national funding of 700 million euros will be allocated to the green transition. The purpose of the national funding is to accelerate the green transition by accelerating energy investments, phasing out fossil fuels in transport, and improving heating solutions for single-family houses and public properties. (Huttunen et al. 2022, 83.)

The war in Ukraine has sped up the green transition. Many European countries have depended heavily on imported energy and especially Russian fossil energy and is green transition offers a way to distance away from fossil fuels and Russian fossil energy. Through green transition, energy self-sufficiency can be improved, and the use of fossil fuel decreased massively if not fully ended. (Sallinen 2022b.)

## 4.1 Fit for 55

In 2021 the European Commission released a package of legislative proposals on climate and green transition called the Fit for 55. It contains 13 legislative proposals that would reduce the EU's net emissions by a minimum of 55% by 2030 and is an important step towards a sustainable society. The goal of the Fit for 55 is to provide the EU with a framework for achieving the EU's climate objectives in a fair and socially just manner while simultaneously maintaining and strengthening the innovation and competitiveness of EU industry and supporting the EU's position as a pioneer in the global fight against climate change. (European Council 2023d.) The minister of the Environment and Climate Change of Finland, Krista Mikkonen, has been positive that the Fit for 55 will help Finland reach its own climate neutrality targets as well. (Finnish Government 2021.)

The legislative proposals in the Fit for 55 cover multiple sectors of the economy, including the EU ETS, energy efficiency, renewable energy, carbon sinks, the land use sector, emissions from cars, energy taxes, and carbon duties. It also imposes specific obligations to each member state based on their gross national income, as a part of the burden-sharing agreement. Some concrete improvements the Fit for 55 brings along are that starting from

the year 2026 a quantitative target will be set for each member state to increase carbon removals. Emissions from agriculture will also be included as a part of the land use sector starting from 2031. The targets for energy efficiency will also be significantly tightened. (Finnish Government 2021.) The EU's objectives are to build interconnected energy systems and integrated energy grids to support the transition to renewable energy sources in the EU. It also aims to decarbonize the gas sector and promote smart integration across different sectors. (European Commission 2023d.)

The EU has a strong track record in reducing carbon emissions while maintaining economic growth, and the green transition receives support from the European Commission via the Technical Support Instrument. The purpose of the instrument is to help national authorities design and put reforms supporting climate ambitions in place. (European Commission 2023d.)

## 4.2 Challenges

Fossil fuels are still the largest energy source used, causing replacing them to require massive amounts of new renewable energy production. Renewable energy on the other hand is unable to resist sudden frequency distractions in situations where a big power plant suddenly fails. It also poses the grand issue of how to deal with windless and cloudy periods. Increasing sustainable energy production requires efficient energy storage solutions. According to energy expert Mika Anttonen, opening new mines for minerals needed for battery production is nowhere near the level that would allow us to rely on batteries for energy storage. The other alternative hydrogen requires enormous amounts of electricity to produce it. (Niskakangas 2022.)

Regardless of the storage solutions used, green transition and building emission-free energy technologies takes a big toll on natural mineral resources. Multiple rare earth elements are essential components for rapidly growing clean energy technologies such as wind turbines, solar photovoltaic cells, and electricity networks for electric vehicles. There have been calculations that the world's mineral reserves are not enough to electrify industry and transportation and to build additional sustainable energy production. The increasing demand and concentrated supply chains may also cause challenges and drive up the costs of energy transitions. The rising demand and increasing importance of minerals require policymakers to consider the potential new vulnerabilities and how to prevent possible risks. (International Energy Agency 2023g.)

As the demand for sustainable energy solutions will undeniably grow exponentially the supply chains of components needs to be paid attention to. China being the number one leading

country in the production of solar panel, battery, and wind power plant components poses another great risk and challenge to Finland and Europe, as we cannot develop another dependency on a non-EU country for critical components and infrastructure. European value chains need to be strengthened to stop that from happening. (Sallinen 2022b.)

As we move towards a green economy and the demand for sustainable goods increases, traditional environmentally damaging goods will start to lose demand. That can and most likely will lead to some people and groups losing their jobs. Some companies will also face a loss of markets. Social policies can be used to soften the fall and facilitate adjustments for the ones who lose their jobs and income. (Cosbey 2023, 54.) The green transition will also on the other hand create new jobs, replacing the work lost because of the structural change (Ministry of Finance Finland 2023).

# 5 Russian energy and the Russia-Ukraine war

## 5.1 Russian energy in Finland and the EU

Russia is one of the biggest players in the global energy market. In 2021 Russia was the third-largest oil producer in the world, the world's largest oil exporter to global markets, and the second-largest crude oil exporter in the world. In 2021 Russia made up 14% of the world's total crude oil supply, and Russia's output of crude oil and condensate was as much as 10.5 million barrels per day. Approximately 60% of Russia's oil exports go to the European member countries of the Organization for Economic Cooperation and Development (OECD) and 20% goes to China. A third of OECD Europe's total oil imports came from Russia in 2021. Russia can ship crude oil in large volumes directly to Europe and Asia due to its extensive export pipeline capacity. (International Energy Agency 2023d.) In terms of natural gas, Russia also is the second-largest producer in the world and has the largest natural gas reserves in the world. It has a wide-reaching pipeline network for exporting natural gas and transit routes through Ukraine and Belarus. Russian gas accounted for 40% of the EU's gas demand in 2021. Russia is also a major player in the LNG market and is the 4$^{th}$ largest LNG exporter in the world, supplying about 8% of global LNG. (International Energy Agency 2023e.) Russia prioritizes self-sufficiency in diesel and gasoline however, and for that reason, it exports minimal values of gasoline and typically about half of its diesel production, much of which comes to Europe. (International Energy Agency 2023f.)

Since the start of the Russia-Ukraine war in February 2022, there has been a lot of demand for information relating to the consumption of Russian energy and Finland's dependency on it. Statistics Finland together with the Natural Resources Institute Finland calculated the share of energy imported from Russia in total energy consumption by sources for the year 2021. It has since also published preliminary data from the year 2022 as well. (Statistics Finland 2023.) In 2021, energy imported from Russia covered 34% of the total energy consumption in Finland. Of all the natural gas consumed, 92% was imported from Russia. Of all the crude oil consumed in Finland, 67% was imported from Russia, and of all the coal consumed 52% was from Russia. Of all products imported to Finland, 12% were Russian products, and of the products imported from Russia, the share of energy was 62%. (Statistics Finland 2021.) In the same year 2021, nine million cubic meters of raw wood and waste wood were also imported to Finland from Russia (Huttunen et al. 2022, 72). From the years predating 2021, there is no existing data on the consumption of Russian energy or Finland's dependence on it. According to Statistics Finland, the share of Russian energy in Finland's total energy consumption by sources cannot be directly concluded from the previously existing data either. (Statistics Finland 2023.)

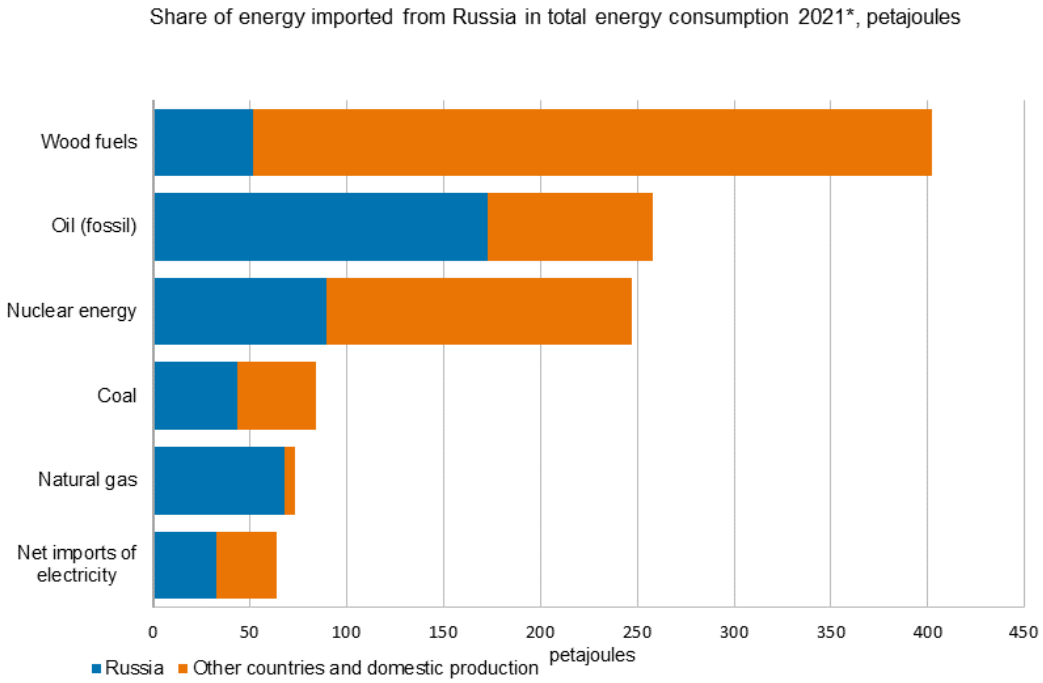


Figure 3. Energy supply and consumption in Finland in 2021. (Statistics Finland 2021)

In many ways, energy has been the glue and connecting force between Russia and the EU. Russia is the main supplier of fossil energy to the EU, and Europe has relied on Russian oil and gas. Finland is no exception in that regard, as a third of the energy used in Finland has traditionally been imported from Russia. (Ministry of Economic Affairs and Employment of Finland 2023.) In 2012, however, Russia developed its strategy and started slightly shifting its oil export dependence away from Europe and towards Asia. In 2019 Russia Launched an eastward gas pipeline to enable sending gas directly to China. Supply agreements and final investment decisions have not been reached yet, but if they were, Russia would become less reliant on gas exports to Europe. (International Energy Agency 2023f.) In 2014 Russia invaded Crimea but the sanctions set on Russia by the EU were moderate. It was thought that the export of energy products was too important for the Russian economy for Russia to use it as a political weapon. The risks of energy import were undermined. Instead, it was thought that Russia could be lured to follow suit with the European development due to the co-dependency in the energy sector. (Sallinen 2022b.) It was thought that the energy and economic co-dependency between Russia and the EU would benefit everyone. According to energy policy researcher Veli-Pekka Tynkkynen especially Germany considered that

it could manage its Russia- related risks with the help of joint energy projects Nordstream I and Nordstream II. (Taussi, Saarikoski 2022.) The partnership on oil and gas started already between the Soviet Union and Germany during the cold war in 1970 when the Soviet Union agreed to expand the pipeline and provide West Germany with natural gas. By 2020 two thirds of Germany's gas came from Russia. (Jha, Brahic, Vaitheeswaran 2022.) Germany's idea of the co-dependency and its benefits were strong up until days before the start of the Russia-Ukraine war. Germany only interrupted the commissioning of the Nordstream II right before the start of the war. According to Tynkkynen, besides Germany, the foreign policy of other European countries including Finland, Italy, and France have helped Russia to drive its objective to make money and increase Europe's dependency on Russian energy. Russia has offered and sold energy to Europe at a slightly lower cost than other producer countries to ensure that Europe would not import energy from elsewhere. (Taussi, Saarikoski 2022.) While energy security and security of energy supply have been at the heart of Finland's energy policy for decades, in 2021 Finland was still relying on Russia for 92% of its gas consumption and 67% of crude oil consumption. While Finland is prepared for supply disruptions by holding and maintaining stocks of imported fuels corresponding to an average of five months' normal consumption, a high dependency on a single supplier country poses still a risk to a nation's energy security and security of supply. (Huoltovarmuuskeskus 2023.)

## 5.2 The Russia-Ukraine war and sanctions on Russia

On the 24th of February 2022, Russia launched its illegal and unprovoked invasion of Ukraine. Russia has illegally annexed the regions of Donetsk, Luhansk, Zaporizhzhia and Kherson in Ukraine and has committed multiple war crimes. In May of 2023, the war is still ongoing. The European Council and the Council of the European Union have continued to meet regularly to discuss the situation in Ukraine. Sanctions against Russia have been expanded regularly, and Ukraine has been provided with financial, humanitarian, political and military support. The sanctions set by the EU against Russia are designed to weaken Russia's economy and deprive it of critical technologies, markets and curtail its ability to wage war. (European Commission 2023e.)

The first package of sanctions was adopted by the EU a day before the invasion and the start of the war in Ukraine in response to the illegal annexation of Donetsk and Luhansk that happened on the 21st of February. The first package included sanctions against individuals, restrictions on economic relations with the annexed areas, and restrictions on Russia's access to the EU's financial and capital markets and services. Since the first round of

sanctions, the EU has adopted nine more packages of sanctions against Russia and has adopted a so-called maintenance and alignment package with measures intended to tighten the existing sanctions and strengthen their effectiveness. (European Council 2023c.)

On the 24th of February 2022, the day the full-scale invasion began, the European Council held a special meeting where it agreed on further restrictive measures. In the meeting, the council discussed the need to work on preparedness and readiness on all levels and to put forward contingency measures, including on energy. (European Council 2023e.) The first sanctions relating to the Russian energy sector were introduced on the 25th of February in the second package of sanctions, but they only related to prohibiting the sale, transfer, supply, or export to Russia of technologies and goods specific to oil refining. The intention was to make sure Russia cannot upgrade its oil refineries. (European Council 2022a.) A few days later EU energy ministers met to discuss the energy situation in Europe and agreed together with the Commission that the EU was not at immediate risk in terms of gas or fuel supplies, even in the situation that there would be a disruption of the supply of Russian gas. The need for contingency measures on energy was acknowledged and discussed as well. (European Council 2023f.)

On the 10-11th of March EU leaders had an informal meeting and adopted a declaration on the Russian invasion of Ukraine, called the Versailles Declaration. It was discussed how the unjustified and unprovoked military aggression against Ukraine violates international law and undermines European and global security. (Versailles Declaration 2022.) In the meeting, EU leaders discussed ensuring the security of energy supplies and agreed to phase out the EU's dependency on Russian gas, oil and coal imports as quickly as possible. In late March 2022, the European Council addressed the increased energy prices and the impact of it. In the fourth round of sanctions introduced in mid-March, the EU prohibited new investments in the Russian energy sector and introduced new restrictions on the export of technologies, equipment, and services for the energy industry. The next round of sanctions adopted in early April 2022 included a prohibition to purchase, import or transfer coal and solid fossil fuels to the EU starting from August 2022, if they are of Russian origin or exported from Russia. It also included a prohibition to import wood from Russia. (European Council 2022b) The sixth package of sanctions was adopted on the 3rd of June 2022, and it included even more impactful sanctions on Russian energy. In the sixth package of sanctions, the EU prohibited the purchase, import and transfer of crude oil and certain petroleum products from Russia to the EU, with temporary exceptions to crude oil delivered by pipeline to countries that are dependent on Russian deliveries due to their geologic location. (European Council 2022c.) On the 3rd of December 2022, the EU agreed on a price cap for crude oil and petroleum oils that originate or are exported from Russia, at 60 dollars per barrel.

The latest and for now last major sanctions on Russian energy were introduced in the tenth package of sanctions on the 25th of February 2023. The sanctions were introduced one year after Russia's invasion of Ukraine and prohibit providing gas storage capacity to Russian nationals to protect the security of gas supply in Europe, and to avoid Russia weaponizing its gas supply and the risks of market manipulation. (European Council 2023g.)

Before the EU could even manage to set sanctions on Russian energy at a larger scale, Russia already started using its energy export as a political weapon. In late March Russian president Vladimir Putin demanded that Russian gas sold to "unfriendly" countries, which included member states of the EU and therefore Finland as well, must start paying for the gas deliveries in roubles. Putin informed that Russia would end its gas export to countries that refuse to make the payments in roubles. (Heiskanen 2022.) On the 20th of May 2022 Russia's state-owned energy corporation and gas export monopoly Gazprom informed Finnish state-owned energy company Gasum that it will cut natural gas deliveries to Finland at 7 am the next day. The deliveries were cut because of Finland not agreeing to Russia's demands to pay for the gas supplies in roubles. In an article released by the Finnish government, it was stated that Finland had prepared for the cutting of Russian gas imports but replacing them would not come without problems. Russia also cut gas deliveries to five other EU countries that similarly refused to pay in roubles. The EU has not set sanctions on Russian natural gas up until now, although it aims to end its dependence on it as quickly as possible. (Finnish Government 2022.)

In June 2022 Gazprom started limiting the flow of natural gas to Germany via the Nordstream I gas pipeline by 40%. At first, Russia informed that the limitation was due to technical issues and maintenance work. Italian energy company Eni reported that gas deliveries to Italy also decreased by 15% for unknown reasons. (Hartikainen 2022.) In August Kremlin spokesperson Dmitry Peskov announced that Russia will stop delivering gas through the Nordstream I, and the Gas supplies to Europe will not resume until the West lifts its sanctions against Moscow. Peskov also admitted that there are no other reasons that would cause problems with pumping gas to Europe at that state, raising doubts about whether there were ever technical issues in the first place. Russia was accused of weaponizing its gas exports and its actions were characterized as blackmail by European leaders. The lower gas flows from Russia triggered an energy crisis in Europe. (Warrington 2022.) Kauppalehti reported that the shutting of gas deliveries through Nordstream I caused the prices of natural gas to surge by tens of percent in early September 2022. (Lehtinen 2022.)

According to the European Council, the sanctions set against Russia have been impactful. It is estimated that Russia's GDP dropped by 2.1% in 2022. Russia's monthly revenues

from oil exports have decreased significantly as well, with the difference in oil export revenues being -41.7% when comparing February 2022 to the February of the previous year. (European Council 2023h.) Statistics Finland calculated together with the Natural Resources Institute Finland that the share of Russian energy of Finland's total energy consumption in 2022 fell by 16% in comparison to the previous year, with it being 34% in 2021 and 18% in 2022. The share of Russian energy in Finland's energy consumption decreased in all energy sources. In wood fuels the import from Russia decreased by 79%, in coal the decrease was 72%, crude oil by 69%, nuclear energy by 4%, and in electricity and natural gas, the import from Russia decreased by 60%. While the import of natural gas has decreased, the import of LNG from Russia has on the other hand increased by 33% in comparison to the previous year.

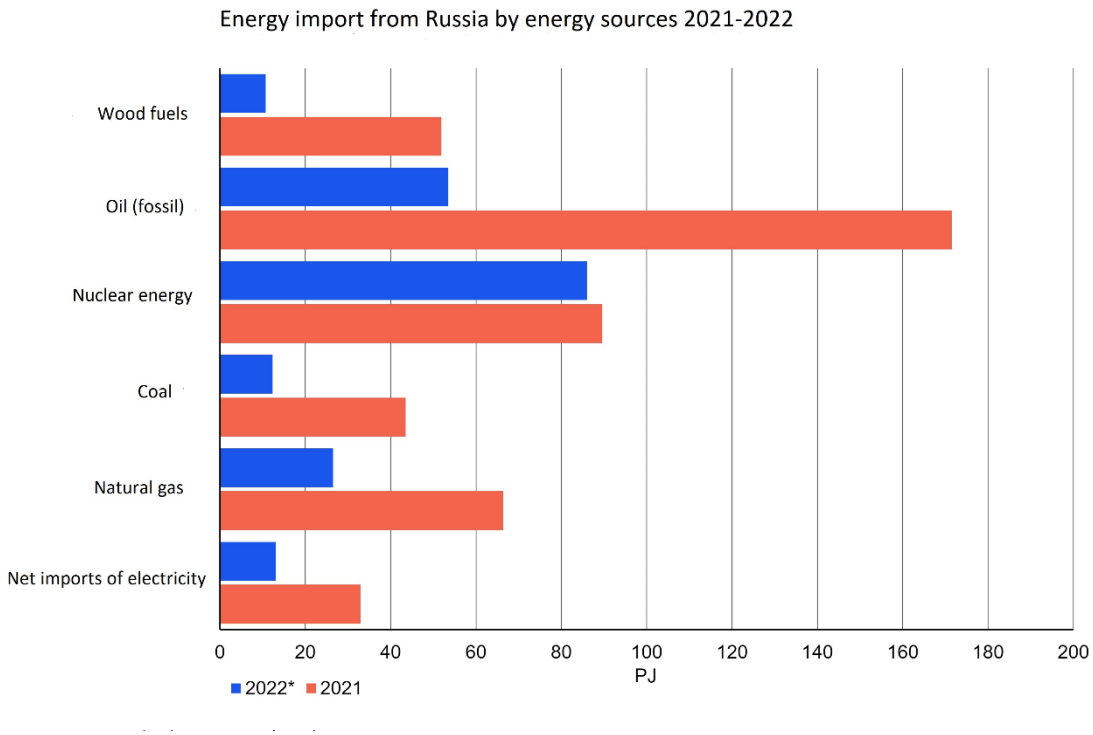


Figure 4 Energy import from Russia by energy sources. (Statistics Finland 2023.)

It is the EU's objective, and Finland's objective to end the reliance on Russian fossil energy. It is stated in Finland's 2022 energy strategy that the green transition is the key to doing so (Huttunen et al. 2022, 10).

In terms of Europe, the International Energy Agency reported that Russia's pipeline flows of gas decreased by 80% of what they were before the invasion. Its oil export to global markets has on the other only decreased slightly so far. Much of the oil is sold at discounts

to international benchmark prices, however, and Moscow has signaled that the production of oil would be cut. (Birol 2023.) The price cap set on oil and sanctions on Russian oil have worked as the Western countries hoped. They have kept Russian oil on the world market and therefore the world market prices under control but have made it difficult for Russia to sell its oil. (Räisänen 2023a.)

The sanctions seem to be working in general, and Russia's budget deficit is skyrocketing. The impact of some of the sanctions will also only be seen in the slightly longer run, such as the impacts of the loss of access to different technologies and financing. A very positive development is that cleaner alternatives to Russian fossil fuels have been growing at a fast pace and added renewable power capacity worldwide rose by approximately 25% in 2022. Investments in energy efficiency increased, and global electric car sales also leaped by nearly 60%. The government policies have been successful in encouraging a faster deployment of clean energy and in identifying and securing new emergency fuel supplies. (Birol 2023.)

While progress was made in 2022 and Europe survived with smaller social and economic hits than initially feared, it is important to note that the situation remains uncertain and fragile in terms of oil and gas markets. Russia is still delivering natural gas to Europe, and the risk remains that it could cut down the supply completely causing challenges. Europe also got lucky with having mild weather in the winter of 2022-2023, lowering the demand for energy. Next winter could be different, however, causing real struggles in the energy sector due to heating. (Birol 2023.)

# 6 The future of Finlands' energy policy

The cost and availability of energy have a significant impact on the quality of life, the health of a nation and its economy, and the relationships between nations. (Chen 2001.) Since February 2022, the Russia-Ukraine war has significantly impacted the cost and availability of energy in Europe. Russia's unjustified military action against Ukraine has resulted in the EU setting strict sanctions against Russia, and on the other hand, Russia has weaponized its gas and energy supplies to Europe. The situation has led to an unprecedented energy crisis in Europe. The war has caused energy prices to soar leading to the prices of goods and services to rise as well. The war has thus accelerated inflation in Finland rapidly. (Suomen Pankki 2023.)

While Finland may start purchasing more Russian energy in the future again, it seems unlikely that the dependence on Russian energy would return to the levels pre-dating the war in Finland or Europe. Finland has ambitious sustainability goals for the year 2035, and simultaneously it is hard to see that the lost trust in Russia could be replenished, even if Russia became willing to supply Finland and Europe with its natural gas and energy again. Since Russia's attack on Ukraine, Finland has stated its objective to phase out Russian energy. It is also the EU's objective to phase out its dependence on Russian oil, gas, and coal imports as quickly as possible. (Huttunen et al. 2022, 164.)

While decoupling from Russia has been a challenge for Finland, Finland has the advantage of having a diverse and relatively resilient energy system before the start of the war. As a result of the previous policy actions, unlike in many other European countries, no energy sector plays a dominant role in Finland's energy system. The Finnish energy mix is well diversified. The green transition was already in progress and an important objective in Finland even before the war, with renewable energy covering already above 40% of Finland's energy consumption. The high number of renewable electricity production and the launch of the new nuclear power plant Olkiluoto 3 into use have helped adapt to losing the energy supplies from Russia. (Tynkkynen 2023.)

Thanks to the diversified energy mix and over 90% of Finland's electricity production being from sustainable energy, Finland is coming out of the energy crisis caused by the Russia-Ukraine war before the rest of Europe. Finland currently has the lowest electricity price for non-household consumers in Europe. (Eurostat 2023b.) Finland is also experiencing unbelievable momentum in green investments, with billions of euros worth of new wind power, offshore wind power, and solar power production in development, as well as investments in

low-carbon steel factories, battery cell production plants, and hydrogen production being in development. (Räisänen 2023b)

While Finland has quickly been able to find ways to replace the lost Russian energy supplies, many other European countries have had more trouble adapting to the changes in the energy market. Germany has been highly dependent on Russian natural gas. Russia cutting its gas supply to Germany has led to an energy crisis and caused the energy prices to rise drastically in Germany, with the prices of wholesale electricity nearly quadrupling. The large industrial sector in Germany relies on the availability of massive amounts of affordable electricity. The soaring electricity prices may cause some of the production to be moved elsewhere. With Finland having the cheapest non-household electricity prices and additional investments in energy production and hydrogen technology underway, it seems possible that Finland may become a desirable destination for Germany and other countries to move some of their production to. (Laatikainen 2023.) In an optimistic scenario, the growing renewable energy production capacity and affordable electricity prices could attract more industry to Finland.

The high amount of renewable electricity production in Finland has led to there being days during the spring of 2023 when the electricity production has exceeded the market capacity. It has caused the electricity prices to turn negative at times and the production capacity needing to be lowered. The recently launched Olkiluoto 3 power plant has been running at lowered capacity. (Pulkkinen 2023.) The unique situation highlights why it is crucial to find efficient and cost-effective ways to store electricity. As the share of weather-dependent energy in total energy production increases, it becomes important that there are ways to store electricity for windless and cloudy days when production capacity is high. Hydrogen will be one of the keys to this. The high level of low-carbon electricity production, good reserves of clean water needed for the electrolysis, and affordable electricity prices for non-household consumers further support the idea that hydrogen production will increase rapidly in Finland in the near future. The hydrogen market will likely grow drastically in Finland over the upcoming years. (Välimäki 2022.)

With all things considered, it seems likely that the Russia-Ukraine war will only speed up the green transition in Finland. Finland is committed to reaching its carbon neutrality targets by 2035, meaning that phasing out fossil energy is an objective of Finland regardless of the Russia-Ukraine war. It is also the EU's objective to lower the carbon emissions produced and to distance away from Russian fossil fuels, which will further support the green transition in Finland. The crisis will likely speed up the process, as some of the lost Russian

energy will be replaced with renewable energy. Finland is currently experiencing great momentum with renewable energy investments causing renewable energy production capacity to grow over the upcoming years. (European Commission 2023a.) The green transition requires major investments in the energy sector and network infrastructure. Strengthening and increasing the flexibility of the electricity system and lowering energy consumption are crucial efforts that need to be taken. In Finland, it is typical that energy is consumed at certain hours of the day in much larger quantities, causing consumption to peak and power plants to be under pressure. The peaks in consumption are already an issue and will cause even more harm as a growing share of our energy consumption is covered by electricity from renewable sources. One of the keys and most economical solutions to this issue and the overconsumption of energy, in general, is to increase energy efficiency. That means for example creating smart solutions to lower energy consumption and repair the construction of buildings. (Sallinen 2022.) We can expect to see new smart solutions, demand-response technologies, and energy-saving technologies for both household and non-household consumers. The hope is that the technology could be sold to international markets as well to create export.

While Finland will continue to electrify its energy systems and work towards becoming carbon neutral by 2035, the use of fossil energy is still by no means over. Transitioning to using more renewable electricity sounds like an easy solution, but it can only solve the emissions problem for processes that can run on electricity. For the processes that cannot run on electricity, zero-carbon fuels that mimic the properties of fossil fuels are required, meaning energy-dense fuels that can be burned. Investments and innovation in biofuels can be expected, but in the meanwhile Russian fossil energy will be replaced with fossil energy from other markets. Replacing Russian oil and coal in Finland is fortunately not a major issue, as oil and coal are global energy sources with multiple suppliers. Several major Finnish companies have already announced that they are changing their source of supply from Russian oil and coal elsewhere, resulting in the import of crude oil and coal from Russia to Finland to end at the end of the existing procurement contracts. What will be more challenging, is replacing Russian natural gas. As Russia cut its natural gas supply to Finland, Finland lost 92% of its natural gas supply. (Huttunen et al. 2022, 166-167.) LNG has become a major key in replacing the natural gas supply from Russia. Finland has rented an LNG hub to increase its security of gas supply. It is likely that renewable electricity will replace some of the lost Russian natural gas, but LNG will play an important role in securing Finland’s gas supply over the upcoming years. (Huttunen et al. 2022, 45.)

In terms of energy sources, it seems unlikely that new traditional nuclear power plants would be built in the future. As explained in chapter 2.3. Finland has become the leading country

in nuclear waste disposal. One could think that having the ability to safely store nuclear waste, and the high electricity prices having cut down Olkiluoto 3's repayment period drastically could encourage building additional power plants. There are still a few reasons that make building additional nuclear power plants unlikely. The first reason is how much of a risky and uncertain investment building a nuclear power plant is for the builder. The builder would have to be able to estimate the electricity prices of the whole repayment period, and that would be a difficult task in this current economy, especially in recent times where electricity prices have been unpredictable to say the least. Russia's attack on Ukraine has also raised concerns about sabotage and attacks on the energy networks and nuclear power plants and nuclear waste sites are easy targets for attacks. While it seems almost certain that additional traditional nuclear plants will not be built in Finland, small nuclear reactors seem like a possible new introduction to Finland's energy sector in the future.

The electricity prices skyrocketed at the start of the war and have been unstable, causing strain on consumers. We may likely see a trend of increase in small-scale energy production in the form of household solar panels and solar collectors, as households want to increase their energy self-sufficiency and possibly avoid having to buy electricity from the grid when prices are high. Households can also sell the excess electricity to the grid, which is beneficial especially during times of high electricity prices. On a larger scale, versatile and multipolar energy production structure increases the security of the energy supply. (Energiamaailma 2023b.) It also seems likely, that in the future solar panels will be built on the top of most if not all new buildings. By adding solar panels on the roof of buildings there would be less of a need to buy electricity from the grid, and on the other hand, the excess energy could be sold to the electricity grid as previously mentioned. (Sallinen 2022.)

Hydrogen will regardless be a major trend in the energy sector in the future, but there have recently been interesting discoveries regarding geologic hydrogen. Scientists have recently discovered that water-rock reactions deep within the earth generate geological hydrogen. According to the U.S. Geological Survey (USGS) model presented in October 2022 at a meeting of the Geological Society of America, there could be enough natural hydrogen to meet the global demand for thousands of years. (Hand 2023.) At the moment all commercial hydrogen must be manufactured, as hydrogen typically occurs attached to other elements in nature. The manufacturing of hydrogen is most typically done by splitting it from natural gas, which produces a lot of emissions, or by splitting it from water molecules using renewable energy in the process, which is expensive. (Viljanen 2023.) What makes the discovery of natural hydrogen so remarkable, is that it is renewable and could potentially be found nearly everywhere, as it is formed by underground water reacting with iron minerals at ele-

vated temperatures and pressures. (Hand 2023.) While there is no promise geologic hydrogen will play a role in Finland's energy sector in the future, the discovery is still something worth noting.

The Russia-Ukraine war will cause Finland to adapt its energy strategy. Finland will phase out Russian fossil energy and increase renewable energy production and consumption. The Russia-Ukraine war has highlighted the importance of securing the energy supply and being prepared for supply disruptions. The green transition will gain speed as Finland phases out Russian fossil energy. The role of the EU will become even more important in the common efforts to phase out Russian energy in Europe and find solutions to the energy crisis. Investments and policy actions may be made to ensure better functioning cross-border energy markets and better interconnections between member states. (EUR-Lex 2023.)

# 7 Summary and discussion

The objective of this thesis was to give background to Finland's energy policy and identify how the Russia-Ukraine war may impact it in the future. The main sources of information were the website of the Ministry of the Environment of Finland, the website of the European Commission, the website of the European Council, as well as various news articles.

The Russia-Ukraine war has had significant impacts on Finland's energy sector and will continue to do so. The sanctions set against Russia and Russia cutting its energy exports to Europe have caused an unprecedented energy crisis in Finland and Europe. The war has highlighted the importance of ensuring the security of the energy supply. Finland must further diversify its energy supply and increase its preparedness for supply disruptions. Moving forward, we must learn from the current crisis that 1. Energy can be used as a political weapon, and 2. We cannot depend on a single country or producer for crucial products. The second point is especially important now as the green transition is at full speed, and China is the leading country globally in the production of components of wind turbines, solar panels, and batteries.

While it has been a grand challenge to adjust to losing Russia's energy supplies, Finland has managed to come out of the energy crisis before the rest of Europe thanks to the policy decisions made in Finland in the past. For the past 25 years, sustainability has played a crucial role in Finland's energy strategies. Needing to lower the number of carbon emissions produced, using a broad range of different energy sources, and taking matters to lower energy consumption has been at the center of Finland's energy strategy for at least 25 years. (Valtioneuvosto 1997, 2479.) In the 2008 energy strategy increasing energy efficiency, stopping the growth of energy consumption, and increasing the share of renewable energy in total energy consumption were underlined. (Valtioneuvosto 2008, 8-9.) Finland investing in green transition and de-carbonizing its energy sector have now helped to overcome the energy crisis in Finland.

Since the war, it has become Finland's objective to phase out Russian energy. The green transition will play a role in doing so. As it is also the EU's objective to phase out Russian energy and move towards a low-carbon economy, the EU's efforts will further support Finland in its transition.

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